Hollow-Fiber Spacesuit Water Membrane Evaporator

Commercial applications include personal coolers for infantry, humidifiers for pilots, and personal coolers for hazmat suits.

Lyndon B. Johnson Space Center, Houston, Texas

The hollow-fiber spacesuit water membrane evaporator (HoFi SWME) is being developed to perform the thermal control function for advanced spacesuits and spacecraft to take advantage of recent advances in micropore membrane technology in providing a robust, heat-rejection device that is less sensitive to contamination than is the sublimator. After recent contamination tests, a commercial-off-the-shelf (COTS) microporous hollow-fiber membrane was selected for prototype development as the most suitable candidate among commercial hollow-fiber evaporator alternatives. An innovative design that grouped the fiber layers into stacks, which were separated by small spaces and packaged into a cylindrical shape, was developed into a full-scale prototype for the spacesuit application.

Vacuum chamber testing has been performed to characterize heat rejection as a function of inlet water temperature and water vapor backpressure, and to show contamination resistance to the constituents expected to be found in potable water produced by the wastewater reclamation distillation processes. Other tests showed tolerance to freezing and suitability to reject heat in a Mars pressure environment. In summary, HoFi SWME is a lightweight, compact evaporator for heat rejection in the spacesuit that is robust, contamination-insensitive, freeze-tolerant, and able to reject the required heat of spacewalks in microgravity, lunar, and Martian environments.

This work was done by Keith Gendreau, Zaven Arzoumanian, Steve Kenyon, and Nick Spartana of Goddard Space Flight Center. Further information is contained in a TSP (see page 1), GSC-16287-1

High-Power Single-Mode 2.65-µm InGaAsSb/AlInGaAsSb Diode Lasers

This innovation is useful for targeted gas detection instruments in environmental monitoring, safety, quality control, and fundamental science applications.

NASA’s Jet Propulsion Laboratory, Pasadena, California

Central to the advancement of both satellite and in-situ science are improvements in continuous-wave and pulsed infrared laser systems coupled with integrated miniaturized optics and electronics, allowing for the use of powerful, single-mode light sources aboard both satellite and unmanned aerial vehicle platforms.

There is a technological gap in supplying adequate laser sources to address the mid-infrared spectral window for spectroscopic characterization of important atmospheric gases. For high-power applications between 2 to 3 µm, commercial laser technologies are unsuitable because of limitations in output power. For instance, existing InP-based laser systems developed for fiber-based telecommunications cannot be extended to wavelengths longer than 2 µm. For emission wavelengths shorter than 3 µm, intersubband devices, such as infrared quantum cascade lasers, become inefficient due to band-offset limitations. To date, successfully demonstrated single-mode GaSb-based laser diodes emitting between 2 and 3 µm have employed lossy metal Bragg gratings for distributed-feedback coupling, which limits output power due to optical absorption.

By optimizing both the quantum well design and the grating fabrication process, index-coupled distributed-feedback 2.65-µm lasers capable of emitting in excess of 25 mW at room temperature have been demonstrated. Specifically, lasers at 3,777 cm⁻¹ (2.65 µm) have been realized to interact with strong absorption lines of HDO and other isotopologues of H₂O. With minor modifications of the optical cavity and quantum well designs, lasers can be fabricated at any wavelength within the 2-to-3-µm spectral window with similar performance. At the time of this reporting, lasers with this output power and wavelength accuracy are not commercially available.

Monolithic ridge-waveguide GaSb lasers were fabricated that utilize second-order lateral Bragg gratings to generate
Optical Device for Converting a Laser Beam Into Two Co-aligned but Oppositely Directed Beams

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Optical systems consisting of a series of optical elements require alignment from the input end to the output end. The optical elements can be mirrors, lenses, sources, detectors, or other devices. Complex optical systems are often difficult to align from end-to-end because the alignment beam must be inserted at one end in order for the beam to traverse the entire optical path to the other end. The ends of the optical train may not be easily accessible to the alignment beam.

Typically, when a series of optical elements is to be aligned, an alignment laser beam is inserted into the optical path with a pick-off mirror at one end of the series of elements. But it may be impossible to insert the beam at an end-point. It can be difficult to locate the pick-off mirror at the desired position because there is not enough space, there is no mounting surface, or the location is occupied by a source, detector, or other component. Alternatively, the laser beam might be inserted at an intermediate location (not at an end-point) and sent, first in one direction and then the other, to the opposite ends of the optical system for alignment. However, in this case, alignment must be performed in two directions and extra effort is required to co-align the two beams to make them parallel and coincident, i.e., to follow the same path as an end-to-end beam.

An optical device has been developed that accepts a laser beam as input and produces two co-aligned, but counter-propagating beams. In contrast to a conventional alignment laser placed at one end of the optical path, this invention can be placed at a convenient position within the optical train and aligned to send its two beams simultaneously along precisely opposite paths that, taken together, trace out exactly the same path as the conventional alignment laser. This invention allows the user the freedom to choose locations within the optical train for placement of the alignment beam. It is also self-aligned by design and requires almost no adjustment.

This work was done by Donald Jennings of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16610-1